

# PATENT ABSTRACTS OF JAPAN

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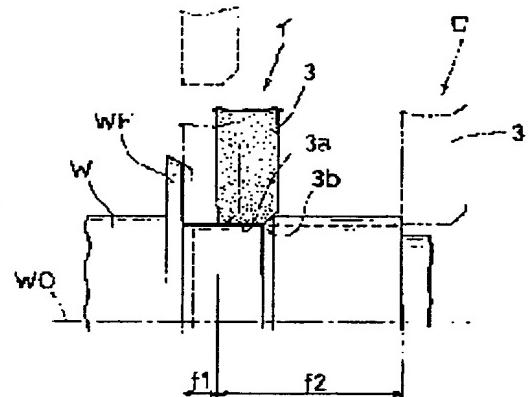
(71)Applicant : TOYODA MACH WORKS LTD  
 (72)Inventor : MUKAI RYOHEI  
 KATSUTA MAMORU

## (54) GRINDING METHOD

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To prevent the shape sagging by performing the traverse grinding of a specified quantity where a grinding wheel surface is slightly separated from a work end surface at a slow speed hardly adding a grinding resistance, in traverse grinding stroke, and switching the speed to a normal high speed after the traverse grinding of the specified quantity to continue the traverse grinding.

**SOLUTION:** In traverse grinding stroke, traverse grinding is performed at a slow speed hardly adding a grinding resistance in a prescribed quantity  $f_1$  where a grinding wheel surface is slightly separated from a work end surface. Since the work W is prevented from being warped at the start of traverse grinding, the circumferential side of the end surface of the flange part WF of the work W is never excessively ground, and shape sagging can be prevented. After the traverse grinding at the low speed of the specified distance  $f_1$ , the traverse grinding is performed at a normal high speed in a distance  $f_2$  from a speed switching position (a) to a traverse grinding complete position (b).



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**CLAIMS****[Claim(s)]**

[Claim 1] It is the grinding approach characterized by for after the late rate which grinding force hardly requires, and traverse grinding of said specified quantity switching the specified quantity to which a grinding stone side estranges a work piece slightly from a work-piece end face in said traverse-grinding stroke in the approach of performing end-face grinding, plunge cutting, and traverse grinding to two steps of rates of the early rate of normal, and carrying out traverse grinding using a thin width-of-face grinding stone.

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the approach of carrying out grinding of the cylindrical shape-like work piece at high speed using a thin width-of-face emery wheel smaller than the processing width of face of a work piece.

[0002]

[Description of the Prior Art] As an approach of carrying out grinding of the cylindrical shape-like work piece at high speed using a thin width-of-face emery wheel smaller than the processing width of face of a work piece, as drawing 5 shows The grinding stone 50 with which straight section 50a and inclined taper section 50b are prepared is used to the axis of rotation WO of a work piece W. As advance migration is made to carry out in the direction of a plunge which intersects perpendicularly with an axis of rotation WO to a work piece W and drawing 6 (a) shows a grinding stone 50 first, the end section of the flange WF of a work piece W It end-face grinding E Carries out in the edge section of straight section 50a of a grinding stone 50, and as drawing 6 (b) shows further, it plunge-cutting P Carries out and is processed to the desired diameter of finishing. Subsequently There is a method of moving a grinding stone 50 in the traverse direction parallel to the axis of rotation WO of a work piece W, traverse-grinding T Carrying out the peripheral face of a work piece W by taper section 50b and straight section 50a of a grinding stone 50, and performing the whole grinding process.

[0003] Since straight section 50a can perform [ taper section 50b of a grinding stone 50 ] rough grinding and perform finish grinding continuously in traverse-grinding T:00 according to this, cylindrical grinding can be performed by the one pass to a work piece W.

[0004]

[Problem(s) to be Solved by the Invention] when the initial speed of traverse-grinding T is quick, drawing 7 R> 7 shows the above-mentioned grinding cycle -- as -- the periphery side of the end face of a flange WF -- width of face of several micrometers -- a configuration -- whom -- t may occur

[0005] Grinding force is very small till termination of plunge-cutting P, it is the effect of this deflection, the end-face section contacts [ to there being almost no deflection of a work piece W since the traverse rate is quick, grinding force becomes large at the flash which traverse-grinding T starts, a deflection arises to a work piece W, ] the end face of a grinding stone 50, and this is because grinding is carried out.

[0006] the object of this invention -- the above-mentioned grinding cycle -- setting -- the periphery side of the work-piece end-face section -- a configuration -- it is offering the grinding approach whose took care to have not generated.

[0007]

[Means for Solving the Problem] It is characterized by for after the late rate which hardly requires grinding force, and traverse grinding of said specified quantity switching the specified quantity to which it is said traverse-grinding stroke and, as for the approach of this invention for attaining the above-mentioned object, a grinding stone side estranges a work piece slightly from a work-piece end face in the approach of performing end-face grinding, plunge cutting, and traverse grinding, using a thin width-of-face grinding stone to two steps of rates of the early rate of normal, and carrying out traverse grinding.

[0008]

[Embodiment of the Invention] The gestalt of operation of this invention is explained based on a drawing below. Drawing 1 shows the grinding process equipment with which this invention approach is enforced, 1 is the bed of grinding process equipment and the wheel spindle stock 2 is laid possible [ an attitude in the direction of X axis ] on this bed 1. The bearing of the grinding stone 3 is carried out to said wheel spindle

stock 2 pivotable. As drawing 2 shows this grinding stone 3, it is thin width of face, and it has the grinding stone layer of a diamond or a nature abrasive grain of superhard like CBN, and straight section 3a and inclined taper section 3b are prepared to the axis of rotation WO of a work piece W. 4 is a motor for a grinding stone revolution, and revolution actuation of the grinding stone 3 is carried out by this. 5 is the X-axis servo motor with which encoder 5a was connected, and carries out attitude delivery migration of said wheel spindle stock 2 in the direction of X axis.

[0009] By the Z-axis servo motor 9 by which encoder 9a was connected ahead of the wheel spindle stock 2 on said bed 1, the table 6 which moves to Z shaft orientations is laid, and a headstock 7 and tail stock 8 are countered and installed on this table 6. The work piece W which has a flange WF in main shaft center 7a of said headstock 7 and \*\*\*\* center 8a of tail stock 8 is supported, and revolution actuation is carried out by the main shaft drive motor built in the headstock 7.

[0010] 11 is numerical-control equipment which controls said grinding process equipment. This numerical-control equipment 11 consists of interfaces 16 which are connected with the interface 13 which connected with I/O device 14 equipped with the central processing unit 12, and the keyboard which performs an entry of data and the CRT display which performs the display of data, and has been connected with said central processing unit 12, the memory 15 linked to said central processing unit 12, and said central processing unit 12, and are connected with the motorised circuits 17 and 18.

[0011] The control data required to perform a processing program and a numerical-control program is memorized by said memory 15.

[0012] It connects with the X-axis servo motor 5, and encoder 5a of the X-axis servo motor 5 has connected one [ said ] motorised circuit 17 to said motorised circuit 17 and interface 16.

[0013] Moreover, it connects with the Z-axis servo motor 9, and encoder 9a of the Z-axis servo motor 9 has connected the motorised circuit 18 of another side to said motorised circuit 18 and interface 16.

[0014] By the absolute location of a headstock 7 and a table 6 being detected by encoder 9a connected with encoder 5a connected with said X-axis servo motor 5, and the Z-axis servo motor 9, a detecting signal is inputted into numerical-control equipment 11 while returning to the motorised circuits 17 and 18 and performing feedback control of a location.

[0015] Then, as the flow chart of drawing 3 shows the grinding process of the work piece W by said grinding stone 3. The advance migration of the grinding stone 3 is made to carry out it in the direction of a plunge which intersects perpendicularly with an axis of rotation WO to a work piece W as usual. It plunge-cutting P Carries out by end-face grinding E Carrying out the end section of the flange WF of a work piece W in the edge section of straight section 3a of a grinding stone 3, and is processed to the desired diameter of finishing. Subsequently traverse-grinding T Move a grinding stone 3 in the traverse direction parallel to the axis of rotation WO of a work piece W, by taper section 3b and straight section 3a of a grinding stone 3, carry out and perform the whole grinding process for the peripheral face of a work piece W.

[0016] By the way, in this invention approach, it is the stroke of traverse-grinding T and the activity of traverse-grinding T shown by drawing 4 differs with the conventional approach.

[0017] That is, in the flow chart of drawing 3, a table 6 is positioned by the command of a grinding cycle in the processing location for the work-piece end-face grinding E (a grinding stone 3 is a dotted-line location at drawing 2). And revolution actuation is carried out and a grinding stone 3 and a work piece W carry out the grinding process of the end face of the flange WF of a work piece W by advance of a wheel spindle stock 2.

[0018] Then, a wheel spindle stock 2 moves forward to the location where grinding of the periphery of a work piece W is carried out to a predetermined finishing dimension, plunge-cutting P is performed, a table 6 traverses leftward [ of drawing 1 ] after completion of this plunge-cutting P, and it goes into the stroke of traverse-grinding T.

[0019] In the stroke of this traverse-grinding T, traverse grinding T1 of a late rate with which a grinding stone side hardly starts the specified quantity f1 slightly estranged from a work-piece end face as for grinding force is performed. since it is suppressed that a work piece W bends by this at the time of initiation of traverse-grinding T, the periphery side of the end face of the flange WF of a work piece W is deleted by the excess -- there is nothing -- the former -- like -- a configuration -- whom -- generating of t is inhibited.

[0020] In the distance f2 from rate switch location I to traverse-grinding completion location RO, it takes traverse-grinding T2 at the quick rate of normal after the traverse grinding T1 of the late rate of said specified quantity f1.

[0021] It is for example,  $5 \times 10^{-2} \leq f1 \leq 1$  [mm] extent, the quick traverse rates of normal are 75 mm/min, and the specified quantity f1 which said grinding stone side incidentally estranges slightly from a work-piece end face makes a late traverse rate late substantially like rate 10 mm/min.

[0022]

[Effect of the Invention] According to this invention, a work piece as mentioned above end-face grinding and when it carries out plunge cutting and goes into a traverse-grinding stroke The late rate hardly applied by grinding force carries out traverse grinding of the specified quantity which a grinding stone side estranges slightly from a work-piece end face. Since it is the grinding approach switched to two steps of rates which carry out traverse grinding of the traverse-grinding completion at the quick rate of normal after that since the grinding force of the flash which traverse grinding starts is reduced and the deflection of a work piece is suppressed by this at the time of initiation of traverse grinding, the periphery side of the end face of a work piece is deleted by the excess -- there is nothing -- a configuration -- whose generating can be prevented. And since the quick amounts of traverses of a rate are few, the effect on grinding efficiency can be suppressed to the minimum.

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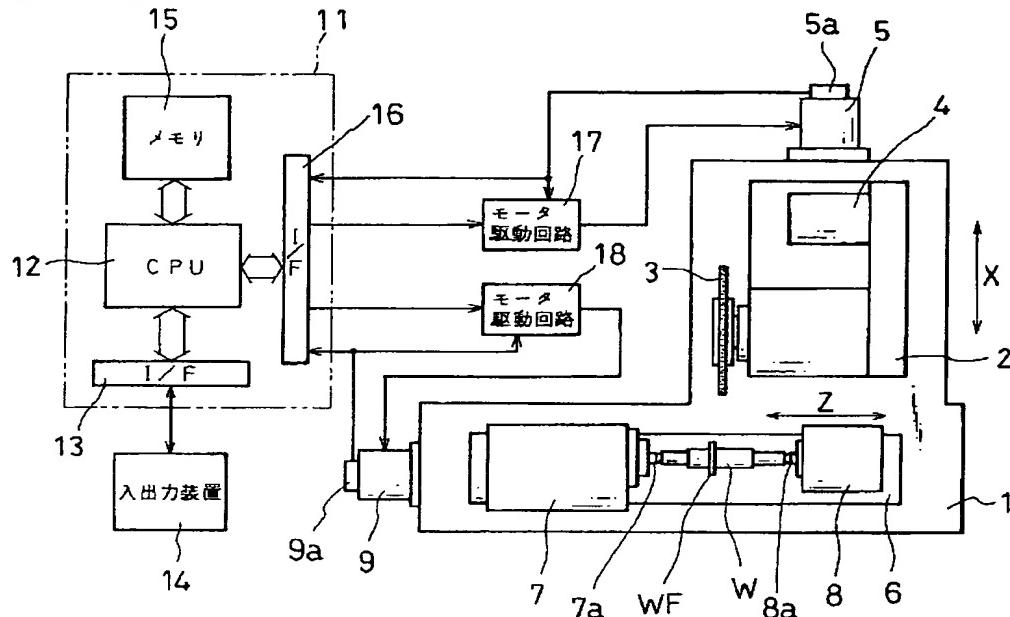
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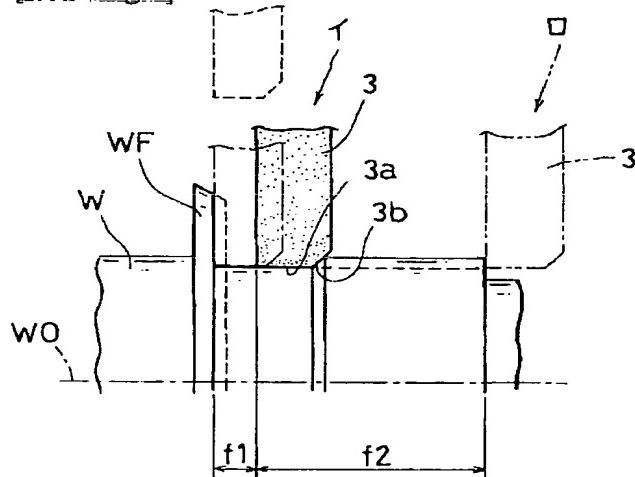
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## DRAWINGS

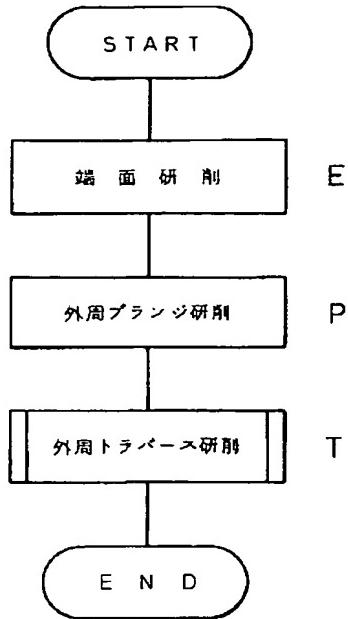
[Drawing 1]



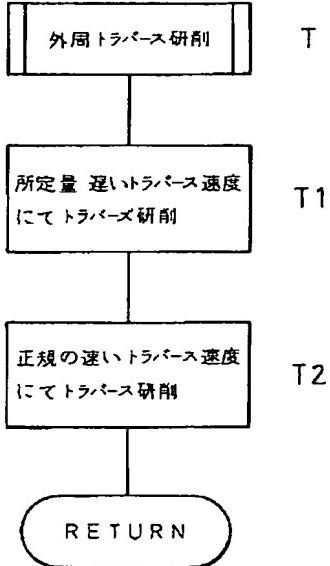
[Drawing 2]



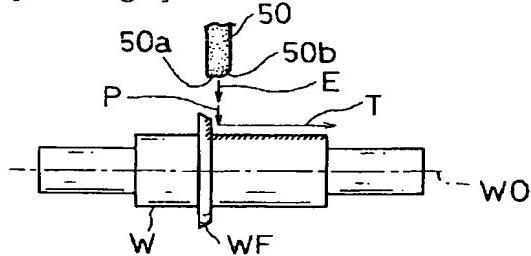
[Drawing 3]



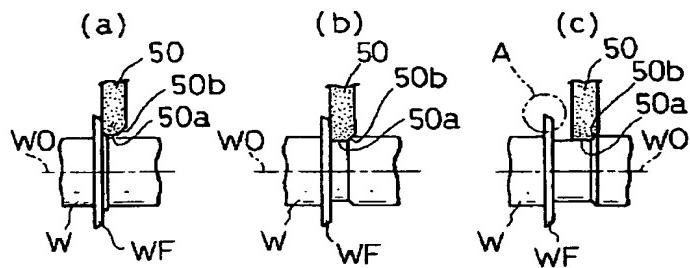
[Drawing 4]



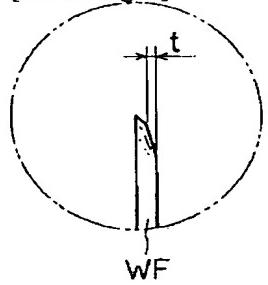
[Drawing 5]



[Drawing 6]



[Drawing 7]



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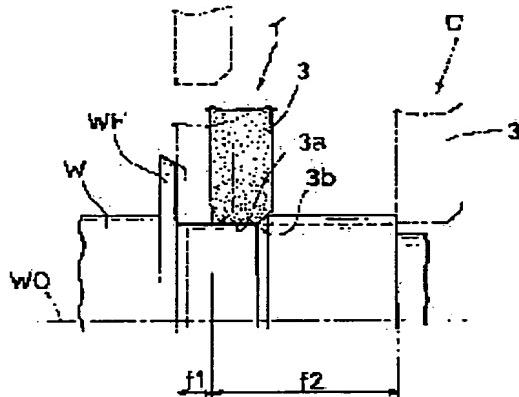
(21)Application number : 08-093029 (71)Applicant : TOYODA MACH WORKS LTD  
 (22)Date of filing : 25.03.1996 (72)Inventor : MUKAI RYOHEI  
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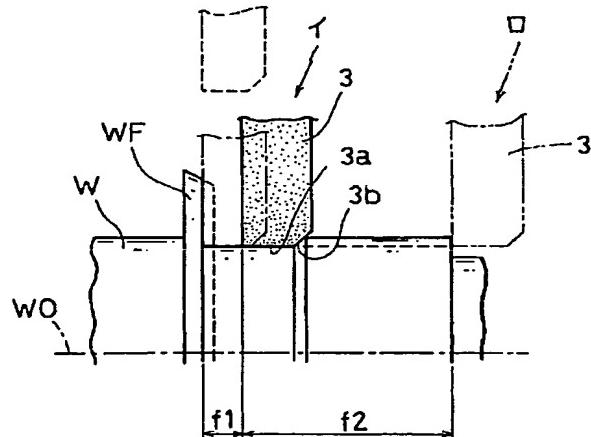
(71)出願人 000003470  
豊田工機株式会社  
愛知県刈谷市朝日町1丁目1番地  
(72)発明者 向井 良平  
愛知県刈谷市朝日町1丁目1番地 豊田工  
機株式会社内  
(72)発明者 勝田 守  
愛知県刈谷市朝日町1丁目1番地 豊田工  
機株式会社内  
(74)代理人 弁理士 平井 二郎

(54)【発明の名称】 研削方法

(57)【要約】

【課題】ワークを端面研削、プランジ研削及びトラバース研削サイクルにおいて、ワーク端面部の外周側に形状だれが発生しないようにした。

【解決手段】トラバース研削行程で、砥石面がワーク端面から僅かに離間する所定量 $f_1$ を殆ど研削抵抗のかからない遅い速度と、前記所定量 $f_1$ のトラバース研削後の研削加工距離 $f_2$ は正規の早い速度の2段階の速度に切り換えてトラバース研削するようにした。



## 【特許請求の範囲】

【請求項1】薄幅砥石を用いてワークを端面研削、プランジ研削及びトラバース研削を行う方法において、前記トラバース研削行程で、砥石面がワーク端面から僅かに離間する所定量を殆ど研削抵抗のかからない遅い速度と、前記所定量のトラバース研削後は正規の早い速度の2段階の速度に切り換えてトラバース研削するようにしたことを特徴とする研削方法。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】本発明は、円筒形状のワークをワークの加工幅より小さい薄幅砥石車を用いて高速で研削する方法に関するものである。

## 【0002】

【従来の技術】円筒形状のワークをワークの加工幅より小さい薄幅砥石車を用いて高速で研削する方法として、図5で示すように、ワークWの回転軸線WOに対しストレート部50aと傾斜したテーパ部50bが設けられている砥石50を用い、先ず砥石50をワークWに対し回転軸線WOと直交するプランジ方向に前進移動させ、ワークWのフランジ部WFの一端部を図6(a)で示すように、砥石50のストレート部50aのエッジ部で端面研削Eし、さらに図6(b)で示すように、プランジ研削Pして所望の仕上げ径まで加工し、次いで、砥石50をワークWの回転軸線WOと平行なトラバース方向に移動させてワークWの外周面を砥石50のテーパ部50bとストレート部50aとによってトラバース研削Tして全体の研削加工を行う方法がある。

【0003】これによれば、トラバース研削T時に砥石50のテーパ部50bにより粗研削を行い、統いてストレート部50aにより仕上げ研削を行うことができるので、ワークWに対して1バスで円筒研削を行うことができる。

## 【0004】

【発明が解決しようとする課題】上記の研削サイクルにおいて、トラバース研削Tの開始速度が速い場合に、図7で示すように、フランジ部WFの端面の外周側に数μmの幅で形状だれtが発生することがある。

【0005】これは、プランジ研削Pの終了時まで研削抵抗が極めて小さく、ワークWのたわみが殆どないのに対し、トラバース速度が速いためにトラバース研削Tが開始する瞬間に研削抵抗が大きくなつて、ワークWにたわみが生じて、このたわみの影響で、端面部が砥石50の端面に接触し、研削されるためである。

【0006】本発明の目的は、上記研削サイクルにおいて、ワーク端面部の外周側に形状だれが発生しないようにした研削方法を提供することである。

## 【0007】

【課題を解決するための手段】上記の目的を達成するための本発明の方法は、薄幅砥石を用いてワークを端面研

削、プランジ研削及びトラバース研削を行う方法において、前記トラバース研削行程で、砥石面がワーク端面から僅かに離間する所定量を殆ど研削抵抗のかからない遅い速度と、前記所定量のトラバース研削後は正規の早い速度の2段階の速度に切り換えてトラバース研削するようにしたことを特徴とする。

## 【0008】

【発明の実施の形態】以下本発明の実施の形態を図面に基づいて説明する。図1は本発明方法が実施される研削

- 10 加工装置を示し、1は研削加工装置のベッドであり、このベッド1上には砥石台2がX軸線方向に進退可能に載置されている。前記砥石台2には砥石3が回転可能に軸承されている。この砥石3は図2で示すように、薄幅であり、ダイヤモンド又はCBNのような超硬質砥粒の砥石層を備えており、ワークWの回転軸線WOに対しストレート部3aと傾斜したテーパ部3bが設けられている。4は砥石回転用モータであり、これによって砥石3は回転駆動される。5はエンコーダ5aが連結されたX軸サーボモータであり、前記砥石台2をX軸線方向に進退送り移動する。

20 【0009】前記ベッド1上の砥石台2の前方にはエンコーダ9aが連結されたZ軸サーボモータ9によってZ軸方向に移動するテーブル6が載置され、このテーブル6上には主軸台7と心押台8と共に対向して設置されている。前記主軸台7の主軸センタ7aと心押台8の心押センタ8aとにフランジ部WFを有するワークWが支承され、主軸台7に内蔵されている主軸駆動モータによって回転駆動されるようになっている。

【0010】11は前記研削加工装置を制御する数値制御装置である。この数値制御装置11は中央処理装置12と、データの入力を行うキーボード、データの表示を行うCRT表示装置を備えている入出力装置14と接続され、かつ前記中央処理装置12と接続しているインターフェース13と、前記中央処理装置12と接続しているメモリ15と、前記中央処理装置12と接続され、かつモータ駆動回路17、18と接続されているインターフェース16とから構成されている。

30 【0011】前記メモリ15には、加工プログラム及び数値制御プログラムを実行するのに必要な制御データが記憶されている。

【0012】前記一方のモータ駆動回路17はX軸サーボモータ5に接続されており、X軸サーボモータ5のエンコーダ5aは前記モータ駆動回路17とインターフェース16に接続している。

【0013】また、他方のモータ駆動回路18はZ軸サーボモータ9に接続されており、Z軸サーボモータ9のエンコーダ9aは前記モータ駆動回路18とインターフェース16に接続している。

【0014】前記X軸サーボモータ5に連結されているエンコーダ5aとZ軸サーボモータ9に連結されたエン

コード9 aによって主軸台7、テーブル6の絶対位置が検出されるようになっており、検出信号はモータ駆動回路17、18に帰還されて位置のフィードバック制御が行われると共に、数値制御装置11に入力される。

【0015】そこで、前記砥石3によるワークWの研削加工は図3のフローチャートで示すように、従来と同様に砥石3をワークWに対し回転軸線WOと直交するブランジ方向に前進移動させ、ワークWのフランジ部WFの一端部を砥石3のストレート部3aのエッジ部で端面研削Eし、ブランジ研削Pして所望の仕上げ径まで加工し、次いで、砥石3をワークWの回転軸線WOと平行なトラバース方向に移動させてワークWの外周面を砥石3のテーパ部3bとストレート部3aとによってトラバース研削Tして全体の研削加工を行うものである。

【0016】ところで、本発明方法においては、トラバース研削Tの行程で、図4で示すトラバース研削Tの動作内容が、従来の方法とは異にしている。

【0017】すなわち、図3のフローチャートにおいて研削サイクルの指令によりワーク端面研削Eのための加工位置（図2で砥石3が点線位置）にテーブル6が位置決めされる。そして、砥石3及びワークWが回転駆動され、砥石台2の前進によりワークWのフランジ部WFの端面を研削加工する。

【0018】続いて、ワークWの外周が所定の仕上げ寸法に研削される位置まで砥石台2が前進し、ブランジ研削Pを行い、このブランジ研削Pの完了後にテーブル6が図1の左方向にトラバースしてトラバース研削Tの行程に入る。

【0019】このトラバース研削Tの行程では、砥石面がワーク端面から僅かに離間する所定量f1を殆ど研削抵抗のかからない遅い速度のトラバース研削T1を行う。これによりワークWがトラバース研削Tの開始時にたわむことが抑えられるため、ワークWのフランジ部WFの端面の外周側が余分に削られることなく、従来のように形状だれの発生を抑止するのである。

【0020】前記所定量f1の遅い速度のトラバース研削T1後においては、速度切り換え位置イからトラバース研削完了位置ロまでの距離f2では正規の速い速度にてトラバース研削T2する。

【0021】因みに前記砥石面がワーク端面から僅かに離間する所定量f1は、例えば、 $5 \times 10 - 2 \leq f1 \leq$

1 [mm] 程度であり、正規の速いトラバース速度は75mm/m inで、遅いトラバース速度は速度10mm/m inのように大幅に遅くする。

#### 【0022】

【発明の効果】以上のように本発明によると、ワークを端面研削、ブランジ研削してトラバース研削行程に入ったときに、砥石面がワーク端面から僅かに離間する所定量を殆ど研削抵抗のかからない遅い速度のトラバース研削し、その後はトラバース研削完了までは正規の速い速度にてトラバース研削する2段階の速度に切り換えた研削方法であるから、トラバース研削が開始する瞬間の研削抵抗が低減され、これによりトラバース研削の開始時にワークのたわみが抑えられるため、ワークの端面の外周側が余分に削られることなく、形状だれの発生が防止できる。しかも速度の速いトラバース量は僅かであるので、研削能率への影響を最少限に抑えることができる。

#### 【図面の簡単な説明】

【図1】本発明方法が用いられる研削加工装置とその数値制御装置の平面図

【図2】本発明の研削方法を示す説明図

【図3】端面研削からトラバース研削までのフローチャート

【図4】トラバース研削の動作内容を示すフローチャート

【図5】従来の研削加工サイクルの説明図

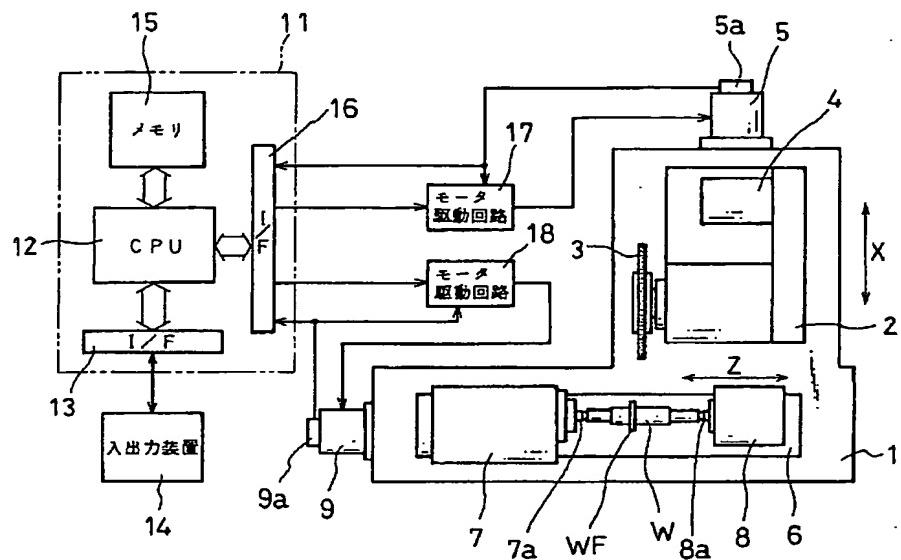
【図6】従来の研削研削状態を示す説明図

【図7】図6(c)のA部拡大図

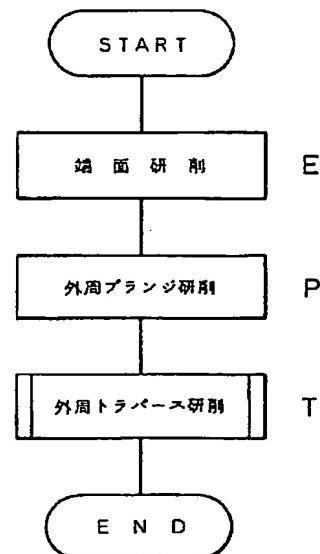
#### 【符号の説明】

30	1	ベッド
	2	砥石台
	3	砥石
	4	砥石回転用モータ
	5	X軸サーボモータ
	6	テーブル
	7	主軸台
	8	心押台
	9	Z軸サーボモータ
	11	数値制御装置
40	f1	遅い速度のトラバース研削を行う所定量
	f2	速い速度のトラバース研削を行う距離

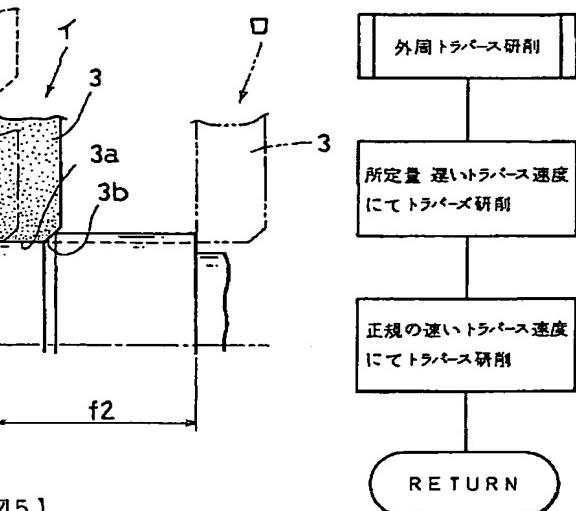
【図1】



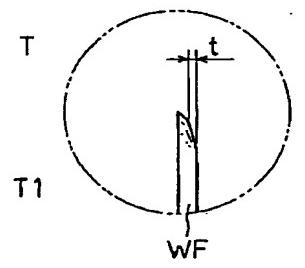
【図3】



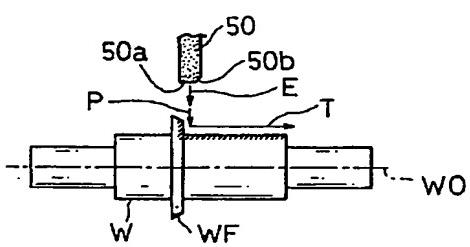
【図2】



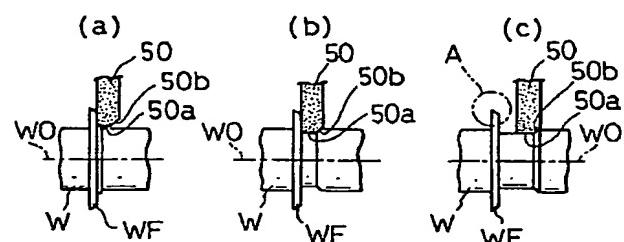
【図4】



【図5】



【図6】



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